LAKE COUNTY, ILLINOIS

2013 NORTH TOWER LAKE SUMMARY REPORT

PREPARED BY THE

LAKE COUNTY HEALTH DEPARTMENT

Population Health Environmental Services

Outlet at North Tower Lake, 2013.

North Tower Lake is an 7.39 acre impoundment that was constructed in 1945. Water leaving North Tower Lake flows into Tower Lake via a stream segment connecting Davlins Pond to Tower Lake. The Tower Lakes are managed by the TLIA.

North Tower Lake is available for use by residents for fishing, swimming, and aesthetics. Gas powered motors are not allowed.

In 2013, it was monitored for water quality by the LCHD-ES. A multiparameter sonde was used to measure water clarity, temperature, pH, dissolved oxygen, and conductivity. Additionally water samples were collected using a Van Dorn sampler and tested for alkalinity, phosphorus, nitrogen, solids, and chloride. Assessments were made of aquatic vegetation, shoreline erosion, land use and the watershed.

The overall water quality of North Tower Lake is poor. Like many of the lakes in the county, it is impaired for phosphorus, based upon the Illinois Environmental Protection Agency's (IEPA) total phosphorus standard of ≥ 0.05 mg/L. The total phosphorus (TP) concentrations in North Tower Lake ranged from 0.043 mg/L to 0.081 mg/L. The 2013 average TP concentration decreased from 0.88 mg/L in 2007 to 0.063 mg/L in 2013; and is slightly below the median TP concentration of 0.067 mg/L for

SPECIAL POINTS OF INTEREST:

- *Phosphorus Impairment*
- *Chlorides*
- *Algal Blooms*

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SUMMARY (CONTINUED)

Lake Facts:

Major Watershed: Fox River

Sub-Watershed: Tower Lake Drain

Location: T43N, R9E, Section 2

Surface Area: 7.39 acres

Shoreline Length: 0.55 miles

Maximum Depth: 9.4 feet

Average Depth: 4.7 feet

Lake Volume: 37.73 acre-feet

Watershed Area: 32.54 acres

Lake Type: Impoundment

Management Entities: Tower Lake Improvement Association

Current Uses: Fishing, swimming, non-motorized boating, aesthetics

Access: Private

lakes in the county monitored for TP between 2000 and 2013.

Phosphorus and nitrogen are normally limiting nutrients in our region. The ratio of total nitrogen to total phosphorus (TN:TP) in 2013 was 18:1. This ratio indicates both nutrients were plentiful enough to cause algal blooms or excessive plant growth.

Total Kjeldahl Nitrogen, (TKN) ranged from 0.745 mg/L in September to 1.440 mg/L in August. TKN is the organic form of nitrogen and is usually tied up in plant and algal cells and therefore is biologically unavailable. The biologically available nitrogen (nitrate, nitrite and ammonium) in the water was non-detectable for the entire season. Any nitrogen that became available was taken up immediately by organisms.

Carlson's Trophic State Index (TSIp) uses average TP to estimate the trophic state of a lake. The TSIp for North Tower Lake was 65 and therefore it is considered an eutrophic or nutrient rich lake. North Tower Lake ranked 72nd out of 175 lakes in the county measured for phosphorus between 2000 and 2013.

There are many potential sources of phosphorus available in North Tower Lake. Internal cycling of phosphorus occurs when DO concentrations become low, ≤2.0 mg/L, in the water near the lake bottom allowing for the release of phosphorus from anoxic (dissolved oxygen ≤1 mg/L) bottom sediments. Eroding shorelines can introduce phosphorus rich sediments into the water column and activities taking place in the watershed such as turf fertilization and supporting a thriving goose population can cause increased TP concentrations. Reminding residents within the watershed to use phosphorus-free fertilizers, repair eroding shorelines and to keep yard waste out of the water are additional practices that can go a long way in reducing phosphorus inputs into North Tower Lake. Finding ways to reduce the need for treatment of plants and algae can also help as nutrients are exuded from dying plant and algal cells.

Algal blooms occurred on North Tower Lake during the entire summer, filamentous blooms were observed by the LCHD-ES occurring around the shoreline and at the outlet. Elevated phosphorus promotes algal growth, and high chloride levels are known to shift algal populations towards blue-green algae. The 2013 average chloride concentration was 236 mg/L; and although it has decreased since 2007 when it was recorded at 255 mg/L, it remains above the critical concentration defined by the U.S. Environmental Protection Agency (230 mg/L) for general use. The main contributing factor of increased chlorides has been linked to deicing products such as rock salt; however, water softener system discharges have also been identified as another source of chlorides and likely contribute to some of the elevated chloride concentrations measured in North Tower Lake. It only requires 1 teaspoon of salt to pollute 5 gallons of water. The entire lake ecosystem can be impacted if concentrations remain at the critical level 230 mg/L for extended periods of time.

An assessment of the aquatic vegetation in North Tower Lake was conducted in July, 2013. Thirty-one points were assessed and 71% percent of the points sampled were colonized by aquatic vegetation. The estimated plant density found in the lake was 23.4%. Plants were not diverse as Small Pondweed and Chara (a macro-algae) were the only two species detected. Curlyleaf and Sago Pondweed were treated in May in North Tower and were not detected at the time of our survey. It is possible that Curlyleaf Pondweed is still present but due to the ephemeral nature of this plant was not detected due to the timing of our survey. The Floristic Quality Index (FQI) score was 7, ranking it 138th of 162 lakes in the county whose FQI was calculated between 2000 and 2013.

The shoreline was assessed for erosion in September and 41% exhibited some degree of ero-

SUMMARY (CONTINUED)

sion; and of that, 39% was considered as having slight erosion occurring on it. Although the amount of erosion found on North Tower Lake in 2013 has decreased since 2007, the severity of erosion increased along a 45 foot length (2%) of shoreline.

WATER CLARITY

Water clarity is measured by Secchi disk. At each visit, the Secchi disk is lowered into the water column at the deepest part of the lake, until it is no longer visible.

In 2013, the average Secchi depth in North Tower Lake was 3.89 feet; and is slightly above the median Secchi depth of 3.00 feet for lakes measured for Secchi depth in the county between 2000 and 2013.

Water clarity in North Tower has decreased each year that LCHD-ES has monitored the lake, from 4.61 feet in 2007 and 5.37 in 2001. In 2001 there were times when the water clarity was such that the Secchi disk could be seen on the bottom. The change in water clarity could be due to the reduction in vegetation in North Tower Lake over the years due to chemical treatment. In 2013, North Tower Lake ranked 67th out of 158 lakes in the county whose average Secchi depths have been measured since 2000.

The monthly Secchi depths in 2013 ranged from 2.75 feet in July to 6.25 feet in September (Figure 1). Algal blooms were likely the cause of the decreased water clarity. Filamentous blooms were observed by the LCHD-ES throughout the entire monitoring season, and noted as mainly colonizing the shoreline and outlet areas of the lake.

Allowing the spread of submerged aquatic plants would improve the water clarity as plants compete with algae for nutrients and light; additionally they secure the bottom sediments and minimize sediment redistribution. This becomes important in shallow lakes such as North Tower

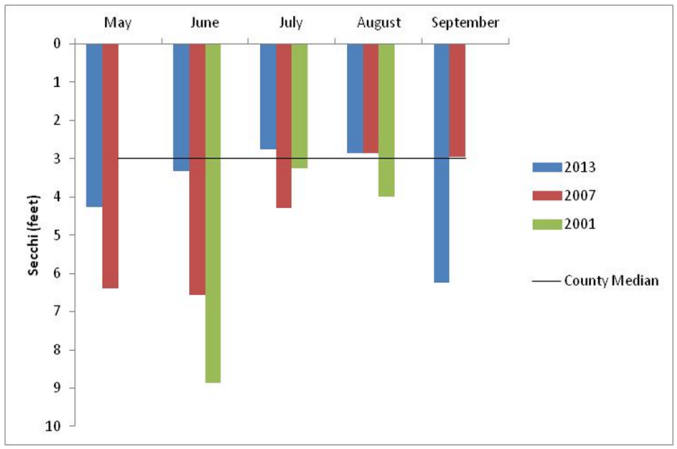


Figure 1. Water clarity in North Tower Lake 2001, 2007, and 2013.

TOTAL SUSPENDED SOLIDS

Total Suspended Solids (TSS) are made up of both volatile solids (TVS), which come from organic sources such as plankton and algae; and non-volatile solids or sediments (NVSS). Both adversely affect water clarity.

During 2013, the average TSS concentration in Tower Lake was 4.4 mg/L. This was a 30% decrease from 2007 when the average TSS concentration was 5.7 mg/L; and is much less than the county median of 8.0 mg/L for lakes measured for TSS between 2000 and 2013.

Figure 2 shows the concentrations of TVS and NVSS found in North Tower Lake during 2013. TVS concentrations ranged from 103 mg/L to a high of 160 mg/L; and were significantly higher than NVSS concentrations. This is reflective of the persistent algal blooms that were observed throughout the entire monitoring period (May - September). The 2013 average TVS concentration was 132 mg/L, this is higher than the county median for lakes sampled since 2000 (119 mg/L).

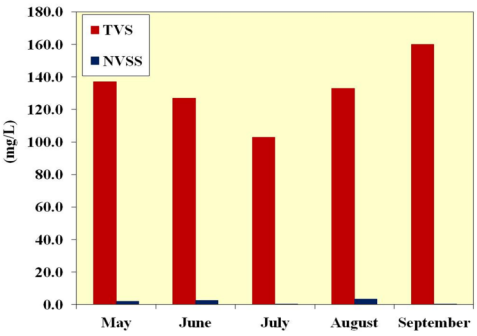


Figure 2. TVS and NVSS concentrations in North Tower Lake, 2013.

NUTRIENTS

Phosphorus and nitrogen are normally limiting nutrients in natural systems. Like many lakes within Lake County, North Tower Lake was impaired for total phosphorus (TP). This is due to TP concentrations of ≥0.05 mg/L occurring on at least one occasion during the monitoring year. In 2013, the average TP concentration on North Tower Lake was 0.063 mg/L. This is slightly lower than the median TP concentration of 0.067 mg/L from lakes in the county monitored since 2000 and the average TP concentration measured in North Tower Lake during 2007 of 0.066 mg/L.

Total nitrogen to total phosphorus ratios (TN:TP) determine which of the two nutrients (phosphorus or nitrogen) limit the growth of plants and algae. Ratios over 20:1 indicate a system limited by phosphorus, under 10:1 the system becomes limited by nitrogen. Ratios falling between 10:1 and 20:1 indicates that the system has plenty of both nutrients to support nuisance plant and algae growth. North Tower Lake was not limited by either nutrient in 2013

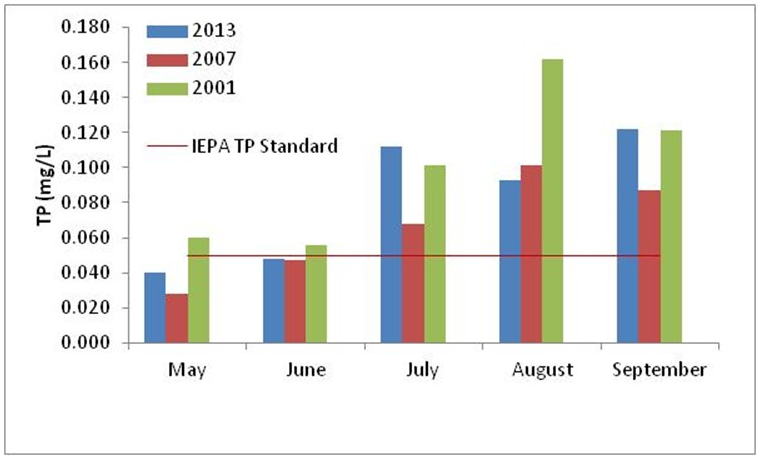


Figure 3. TP concentrations in Tower Lake 2001, 2007 and 2013.

Nutrients (continued)

with an overall TN:TP ratio of 18:1; therefore, there was sufficient nutrients in the system to support nuisance plant or algal populations.

North Tower Lake is considered an eutrophic lake based upon its Trophic State Index (TSIp) score of 65. The TSIp is based upon the total average phosphorus concentration. The higher the score the more nutrient enriched the lake is. North Tower Lake ranked 72nd out of 175 lakes from the county that were assessed for phosphorus between the years 2000 and 2013.

Phosphorus (P) can be introduced into a system either from external sources (i.e. watershed) or internally from bottom sediments. Anoxic (≤ 1 mg/L DO) sediments release phosphorus into the water column and can occur when waters above the sediment are still oxic at approximately 2 mg/L (Nurnberg, 2013).

North Tower Lake had anoxic conditions occur during July and August; and exhibited polymictic tendencies (mixing of lake waters more than once during the season) as it thermally stratified in May and then again in July. Because of this, the lowest hypoxia (low oxygen condition) may not always have been exhibited, meanwhile anoxic sediments continually released P into the system.

The internal cycling of phosphorus may have contributed to the algal blooms observed on North Tower, but it also could be due to the low density of plants in the lake as well as nutrients being released from dying plant and algal cells remaining in the water after chemical treatment.

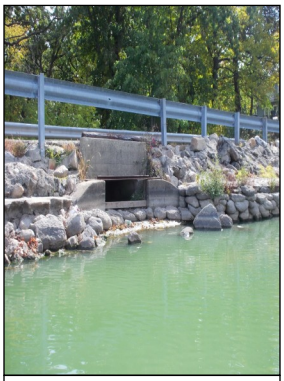
LCHD-ES recommends that TLIA encourage plant growth by native species in North Tower Lake as well as its residents to utilize best practices for reducing phosphorus inputs, such as minimizing goose populations, using phosphorus free fertilizers, remediating eroded shorelines and keeping yard waste out of the lake.

OLIGOTROPHIC:

Lakes are generally clear, deep and free of weeds or large algae blooms. Though beautiful, they are low in nutrients and do not support large fish populations.

MESOTROPHIC:

Lakes lie between the oligotrophic and eutrophic stages. Devoid of oxygen in late summer, their hypolimnion limit cold water fish and cause phosphorus cycling from sediments.



EUTROPHIC: Lakes are high in nutrients, they are usually either weedy or subject to frequent algae blooms, or both. Eutrophic lakes often support large fish populations, but are also susceptible to oxygen depletion.

Figure 4. Trophic states illustrated.

WATERSHED

The watershed of North Tower Lake is small, estimated to be 32.54 acres. Land use in the watershed is comprised of 5 categories (Appendix A, Table 1). The dominant land uses were Single Family (50.0%), and Water (24.9%), followed closely by Transportation (20.4%). The sources of percent total estimated runoff are almost exclusively from Single Family (58.3%) and Transportation (40.5%). The watershed to lake volume is about 1:1, and therefore it has a retention time of approximately 1.81 years. Therefore, pollutants in the lake are trapped there for a while before the waters are turned over, so it becomes important for residents in the watershed to maintain their properties so that they cause as little impact as possible to North Tower Lake. Keeping yard waste out of waters, using phosphorus free fertilizers, and being conscience about using deicers and not allowing water softeners to discharge into North Tower Lake all can go a long way in alleviating some of the water quality problems addressed in this report.

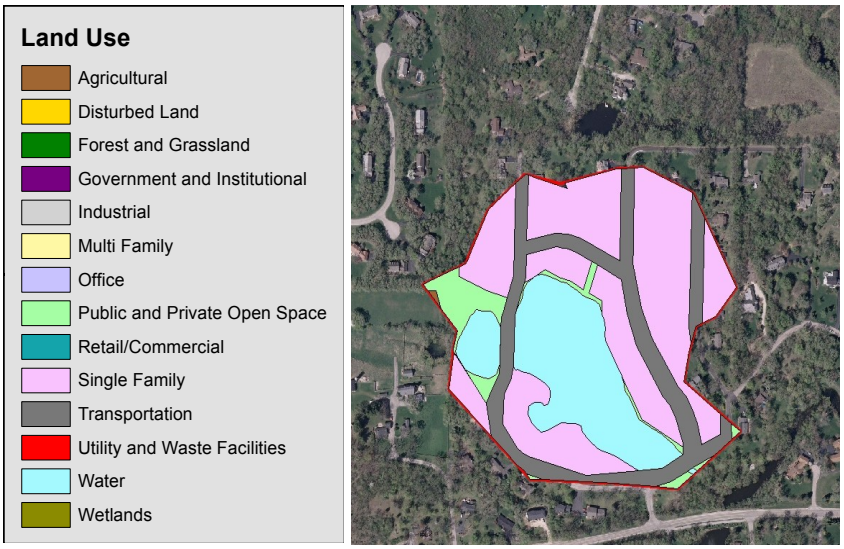


Figure 5. Land use within North Tower Lake watershed, (data collected from 2010 imagery).

DISSOLVED OXYGEN (DO)

Dissolved Oxygen (DO) is essential for the survival of fish and invertebrates and influences many different biological and chemical processes in lakes.

North Tower Lake was anoxic near the bottom in July and August, 2013. Additionally, it exhibited polymictic tendencies as it thermally stratified in May and July. Lakes which are polymictic may not indicate the lowest hypoxia observed in the water column at all times. DO concentrations of ≤2 mg/L in the water near the lake bottom are low enough to cause hypoxia in the bottom sediments and phosphorus release to occur. When the lake was anoxic near the bottom there was soluble reactive phosphorus (SRP) present in the water column. This is due to there being just too much phosphorus in the system and organisms could no longer take it up. SRP is the biologically available form of phosphorus, and is usually taken up immediately by aquatic organisms. Since North Tower Lake is not limited by either phosphorus or nitrogen, it is important to try to avoid imputs of these nutrients into North Tower Lake. TLIA may want to consider installing an aeration system into the lake to prevent the stratification of lake waters. A minimum of 0.47 horsepower will be required to destratify North Tower.

Since phosphorus is easier to manipulate due to nitrogen coming from sources such as the atmosphere, catalytic converters etc., steps should be taken from the residents to reduce phosphorus inputs into the watershed.

DO can also become supersaturated, this occurs when the % DO is elevated above 100%. If DO saturation greater than 110% is maintained in the water for extended periods of time, adverse impacts can occur to fish. In rare cases, excessive DO can lead to gas bubble disease, where oxygen bubbles or emboli block the blood flow through blood vessels.

North Tower Lake had elevated % DO occurring in the water column to 4 - 5 feet from the surface during most of the monitoring season (Appendix A, Table 5). The elevated % DO was likely due to photosynthesizing algae.

CHLORIDES/CONDUCTIVITY

Conductivity measures the amount of ions contained in a waterbody. The more ions or salts that a waterbody contains the higher its conductivity. Conductivity can be used to estimate both total dissolved solids (TDS) and chloride concentrations due to a strong correlation between these parameters. LCHD-ES has decided in more recent years to analyze chloride concentrations due to a strong relationship discovered between road salt usage (which contains 40% chloride) and increasing chloride concentrations in lakes. Even more recently water softeners have been found to play an important role in increasing chloride concentrations in water. It only takes 1 teaspoon of salt (chloride) to pollute 5 gallons of water (230 mg/L). Once chlorides are in the water they remain there indefinitely, unless the water is somehow diluted or treated by a reverse osmosis system, the latter being a very expensive alternative.

It only takes1 teaspoon of salt to pollute 5 gallons of water.

In 2013, the average chloride concentration in North Tower Lake was 236 mg/L, although it decreased from 2007 when the average chloride concentration was 255 mg/L, it remains above the critical concentration of 230 mg/L. In 2013, chlorides ranged from 218 mg/L in June to a high of 250 mg/L in September (Figure 6). Normally, higher chloride concentrations occur earlier in the season due to snowmelt runoff; however, concentrations in North Tower increased over the summer months indicating that it may be impacted by water softener discharges. Adverse impacts to aquatic ecosystems and their inhabitants are known to occur if the critical chloride concentration is maintained for prolonged periods and shifts in algal populations are known to occur at concentrations as low as 12 mg/L.

Single family and transportation were estimated to be the two highest contributors of runoff in the watershed in 2013; and therefore residents should be considerate of their salt usage whether it be from winter maintenance or water treatment. The "What can I do to help?" tip box that follows, provides tips on how you can reduce salt use around your home.

The LCHD-ES and Lake County Stormwater Management Commission (LCSMC) have been holding annual training sessions targeting deicing maintenance personnel for both public and private entities.

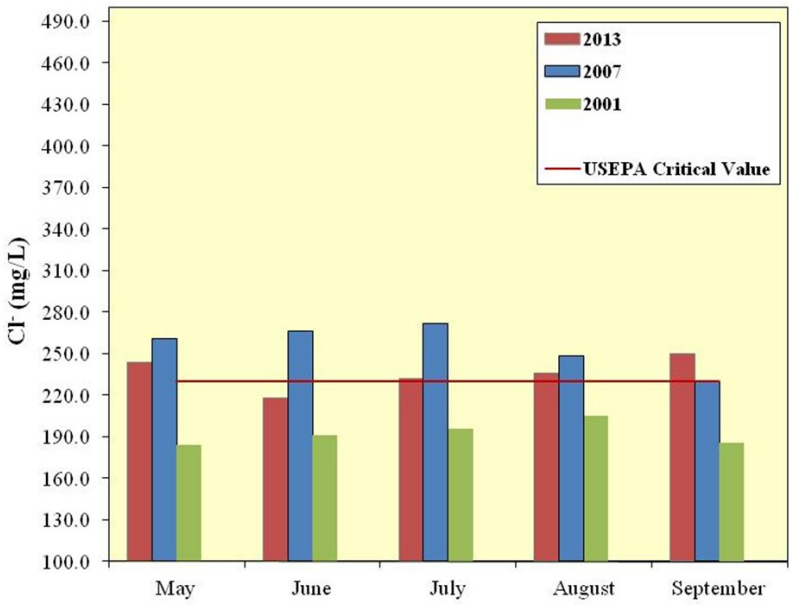


Figure 6. Chloride concentrations in North Tower Lake, 2001, 2007 and 2013.

CHLORIDES (CONTINUED)

This is an attempt to educate winter road maintenance crews on the recommended application rates for applying deicers and hopefully will reduce the amount of chloride being introduced into our environment while maintaining safe passageways.

Almost all deicing products contain chloride so it is important to read the product label for proper application. For instance, at 10° Fahrenheit, rock salt is not at all effective in melting ice and will blow away before it melts anything. Homeowners should contact the local agency responsible for snow removal to encourage them to implement practices that reduce the usage of deicing products on their properties and roadways.

What can I do to help?

- Shovel (or use a snow blower) before you use any product; never put a deicing product on top of snow.
- Read the product label, before applying product.
- Sweep up un-dissolved product after a storm is over for reuse.
- Consider switching to a non-chloride deicer.
- Support changes in chloride application in your municipality.
- Inform a neighbor about the impacts chlorides have on our lakes rivers and streams.

Modified from (DuPage River Salt Creek Workgroup , 2008)

ALGAE

In 2013, filamentous algal blooms were prevalent on North Tower Lake and subject of treatment on three occasions. Although the filamentous algae found on North Tower does not pose a threat to human or pet health, Tower Lake did experience a blue-green algal bloom which caused a swim ban at East Beach until the bloom was treated and had cleared.

Phosphorus is the underlying cause for most algal blooms and North Tower Lake had sufficient nutrients available to support blue-green algal blooms. Blue-green algae are actually cyanobacteria and when in bloom they have the potential to produce toxins such as microcystin; a common toxin produced by blue-green algae. These blooms are therefore termed harmful algal blooms (HABs) as they can have adverse effects on humans; although the presence of HABs does not mean that toxins are present. The sample collected in Tower Lake during their bloom tested positive for presence of microcystin however, the results of an enzyme-linked immunosorbant assay (ELISA) indicated the levels of toxin were well below the World Health Organization (WHO) standard for no contact of 20 ug/L (Table 1).

Since it remains unclear what causes HABs to release toxin, the LCHD-ES recommends that HABs not be chemically treated, but left to complete their cycle. Due to the high phosphorus concentrations and history of algal blooms found in North Tower, it is highly recommended that an action plan be developed that will be followed in the event of a blue green algae bloom occurring in North Tower at some time in the future.

Sample Date	Elisa ug/L	Abraxis
10-Jun	<0.15	NA
24-Jun	<0.15	NA
8-Jul	<0.15	NA
22-Jul	<0.15	NA
26-Jul	NA	2.5
29-Jul	8.23	5
31-Jul	0.37	0
31-Jul	5.82	1
5-Aug	0.19	NA
19-Aug	0.51	NA
17-Sep	NA	0

Table 1. Results from HAB samples in Tower Lake, 2013.

AQUATIC PLANTS

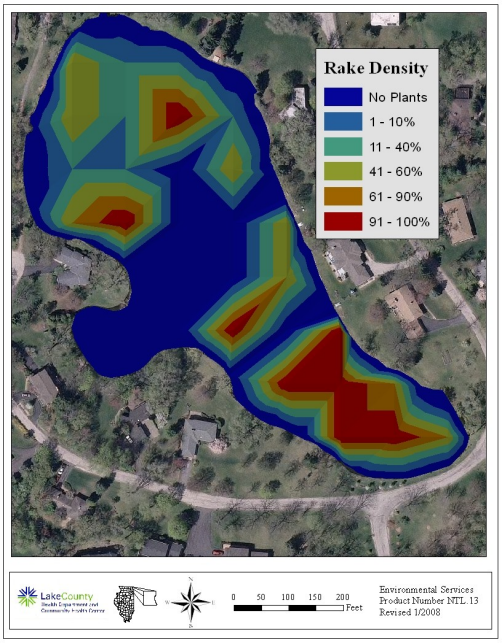


Figure 7. Rake density and location of aquatic vegetation in North Tower Lake, 2013.

Aquatic plants are a critical feature in lakes as they compete against algae for nutrients, improve water quality and provide fish habitat for nesting and nursery. An aquatic vegetation survey was conducted in July, 2013. A 60-meter grid was randomly overlaid on an aerial photo of North Tower Lake and a total of 31 points fell within the lake footprint and were assessed.

Seventy-one percent of the points sampled were vegetated. It is estimated that the total plant density was 23.4%. Small Pondweed and Chara (a macroalgae) were the only two species detected in the 2013 quantitative survey. Curlyleaf Pondweed and Sago Pondweed were treated in May and were not detected in the July survey. The lack of Curlyleaf Pondweed could be due to the ephemeral nature of this species or in the case of both Curlyleaf and Sago Pondweed, that control efforts had successfully minimized the population. LCHD-ES recommends allowing expansion of native plant populations to attain higher levels of cover. This will provide greater competitive pressure to algae and hopefully decrease their occurrence.

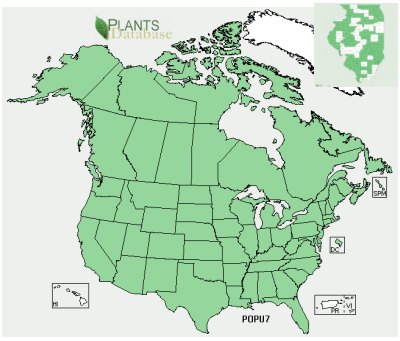
Plant diversity in North Tower Lake is low; and therefore the floristic quality index (FQI) was low with a score of 7. North Tower Lake never had a diverse flora, with Small Pondweed, Curlyleaf Pondweed and Chara being the only species ever found by the LCHD-ES. Floristic quality assessments are used in natural areas and allow for comparison among sites. An FQI of 35 is considered of marginal quality. Most lands in the Chicago region score an FQI of 20 or lower and essentially have no significance from a natural perspective (Swink and Wilhelm,1994). Tower Lake ranked 138th of 162 lakes assessed in the county for floristic quality between 200 and 2013.

Table 2. Aquatic plants detected in North Tower Lake during 2013.

Common Name	Scientific Name
Chara	Chara spp.
Small Pondweed	*Potomogeton pusillus*

SMALL PONDWEED

Small Pondweed (*Potomogeton pusillus),* a native submerged aquatic plant species tolerant to turbid water. A pair of glands where the leaf meets the stem is a distinguishing feature of this species, although this cannot be detected without a magnifying lens.



AQUATIC PLANT MANAGEMENT - PESTICIDES

FOR FULL DETAILS OF THE PESTICIDE RULE SEE:

HTTP://WWW.EPA.STATE.IL.US/WATER/PERMITS/PESTICIDE/INDEX.HTML

Like Tower Lake, North Tower Lake is a heavily managed lake. The Tower Lakes are broken down into eleven management units; Unit 1 is North Tower Lake (Figure 6). Rollins Aquatic Solutions, Inc., surveyed and treated the lake for aquatic vegetation and/or algae on three different occasions during the season, May - September. In May the focus of treatments was Curlyleaf Pondweed, filamentous algae and Sago Pondweed, They were treated with an Algicide; Aquathol K, which is an endothall liquid used to treat a broad range of aquatic plants, and Tribune, a diquat bromide used to treat pondweeds. It was treated a second time in late June for Chara, filamentous algae and Phragmites using copper sulfate and finally in August for Sago Pondweed and filamentous algae using diquat and copper sulfate.

During the 2013 quantitative vegetation survey, the lake was found to have a total average plant density of 23.4%. LCHD-ES did not encounter any Curlyleaf or Sago Pondweed during this survey. Filamentous algae was observed along the shorelines on many of the site visits.

The LCHD-ES recommends that the TLIA consider only treating for Curlyleaf Pondweed, unless Eurasian Water Milfoil appears at sometime in the future. Allowing for expansion of native plants such as Sago and Small Pondweed will help to alleviate the need for treatment of algae on the lake as plants will compete for nutrients against algae, hence suppressing their populations. LCHD-ES supports the chemical management of the non-native and invasive species, Common Reed Grass (Phragmites spp.).

Figure 8. Treatment area map for the Tower Lakes, 2013.

Shoreline Erosion

Shoreline erosion contributes to poor water quality by increasing both TSS and TP concentrations with either one of two outcomes, a very weedy lake due to an increase in a normally limiting nutrient (phosphorus) or a lake with few weeds due to decreased water clarity from excessive amounts of sediment or algae being in the water column.

In 2013, 41% percent of the 0.55 mile shoreline was experiencing some degree of erosion (Figure 7). Although the amount of eroding shoreline has decreased since 2007 when 96% of the shoreline exhibited some degree of erosion; there was approximately 45 feet of shoreline discovered in 2013 that had increased in severity from having slight to moderate erosion occurring upon it. Remediation of some areas previously documented with slight erosion explains the decrease in overall erosion on North Tower Lake. In 2013, only 39% of the shoreline was considered slightly eroded and an additional 2% exhibited moderate erosion. Some of the shoreline that was documented as being slightly eroded remained unchanged from 2007. It is recommended that homeowners implement controls soon as it is easier to remedy slightly eroded shorelines. There are several alternatives available, but native plantings can provide sufficient erosion control due to the plants having deep root systems , they also have an added benefits such as nutrient removal and habitat for native fauna. In areas with moderate erosion there may be a need to combine hardscaping and native plantings in order to be effective.

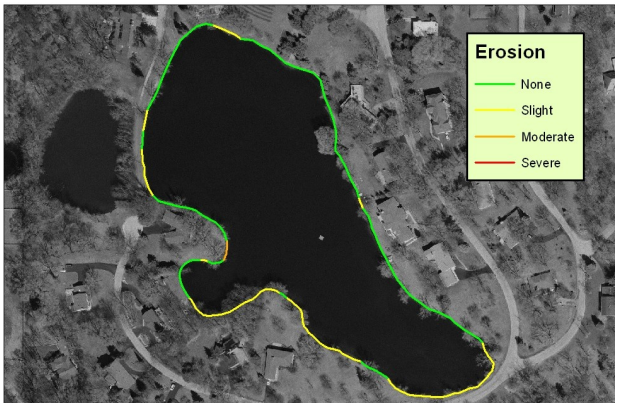


Figure 9. Shoreline erosion assessed on North Tower Lake, 2013.

Figure 10. Example of using hardscaping and native plantings

Table 3. Degree of erosion on North Tower, 2013		
Erosion	Miles	Percent
None	0.32	59%
Slight	0.22	39%
Moderate	0.01	2%
Severe	0.00	0%

VLMP

In 2012, a volunteer lake monitor (VLMP) collected Secchi depths on North Tower Lake on June 14th and July 16th; the depths were recorded at 31 inches and 17 inches, respectively. These Secchi depths are below the median Secchi depth of 3.00 feet for lakes in the county measured between 2000 and 2013. VLMP data is useful on years when North Tower is not being actively monitored by the LCHD-ES, however, in order for it to be useful, a minimum number of depths are required by the state. If collected properly, VLMP data can provide useful information to help understand what has taken place or is impacting the lake in a given year. LCHD-ES recommends that a VLMP from the Tower Lakes area be recruited to collect Secchi data in future years. Volunteers can contact the LCHD-ES for more information at (847)377-8030.

BATHYMETRIC MAP

North Tower Lake is lacking a bathymetric map. LCHD-ES recommends that lakes that participate in aquatic plant or fishery management have a bathymetric map and accompanying morphometric data in order to assist with decisions on these activities. A bathymetric map is a useful tool for lake managers as it assists with estimating volumes for lake treatment and other decisions involved with the overall plant management plan. It also allows for evaluation of anoxic water volumes which are helpful in managing and maintaining a fishery.

LakeCounty
Health Department and
Community Health Center

ENVIRONMENTAL SERVICES

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For more information visit us at:

http://www.lakecountyil.gov/Health/want/BeachLakeInfo.htm

Protecting the quality of our lakes is an increasing concern of Lake County residents. Each lake is a valuable resource that must be properly managed if it is to be enjoyed by future generations. To assist with this endeavor, Population Health Environmental Services provides technical expertise essential to the management and protection of Lake County surface waters.

Environmental Service's goal is to monitor the quality of the county's surface water in order to:

- Maintain or improve water quality and alleviate nuisance conditions
- Promote healthy and safe lake conditions
- Protect and improve ecological diversity

Services provided are either of a technical or educational nature and are provided by a professional staff of scientists to government agencies (county, township and municipal), lake property owners' associations and private individuals on all bodies of water within Lake County.

RECOMMENDATIONS

LCHD-ES recommends the following actions for improving the water quality and overall health of North Tower Lake:

- Use best management practices to reduce phosphorus and chlorides from being introduced into the lake. Practices such as using phosphorus free fertilizers, remediating eroding shorelines and keeping yard waste out of the lake reduce phosphorus inputs. Using deicers wisely and making sure that water softeners do not discharge into North Tower will additionally reduce chloride inputs.
- Promoting the spread of native vegetation in the lake to compete against algae for nutrients and also provide fish habitat.
- Repair eroding shorelines will improve water clarity and reduce TP concentrations in North Tower Lake. This can be accomplished through a mix of hardscaping and native plantings. Proper rock size and installation is necessary to ensure long term success.
- Development of an action plan for the handling blue-green algal blooms (HABs) so that there is a standard procedure that can be followed in the event of blue-green algal blooms occurring in the Tower Lakes in the future.

STOP AQUATIC HITCHHIKERS!™

Prevent the transport of nuisance species.
Clean all recreational equipment.
www.ProtectYourWaters.net

When you leave a body of water:

- Remove any visible mud, plants, fish or animals before transporting equipment.
- Eliminate water from equipment before transporting.
- Clean and dry anything that comes into contact with water (boats, trailers, equipment, clothing, dogs, etc.).
- Never release plants, fish or animals into a body of water unless they came out of that body of water.

APPENDIX A

FIGURES AND TABLES
NORTH TOWER LAKE
2013

Figure 1. LCHD water quality sampling point – North Tower Lake 2013.

Figure 2. Approximate watershed boundary of North Tower Lake, 2013.

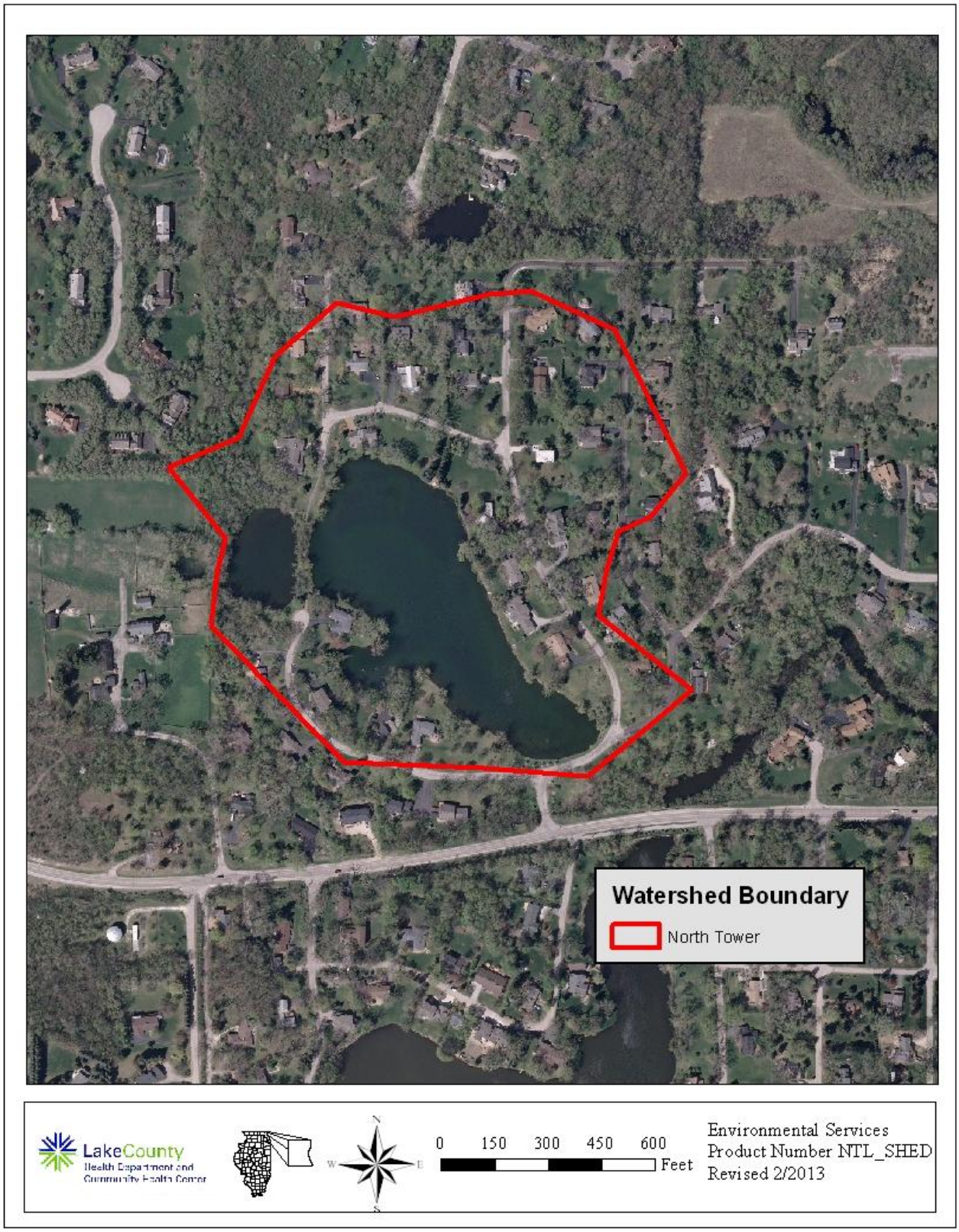

Figure 3. Land use of North Tower Lake watershed, 2013. Based upon 2010 imagery.

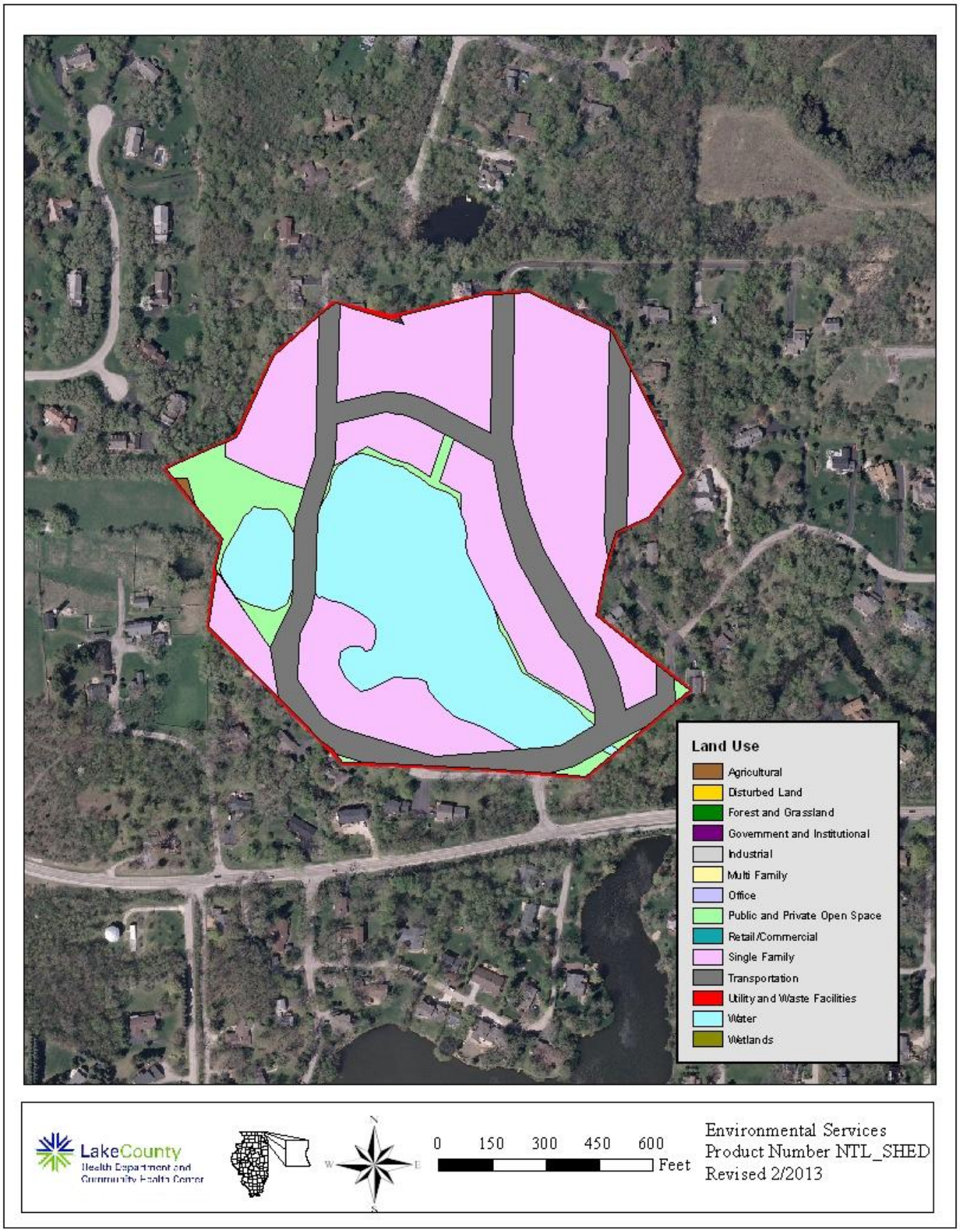

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Table 1. Approximate land uses and retention time for North Tower Lake, 2013.

Land Use	Acreage	% of Total
Agriculture	0.03	0.10%
Disturbed Land	0.00	0.00%
Forest and Grassland	0.00	0.00%
Government and Institutional	0.00	0.00%
Industrial	0.00	0.00%
Multi Family	0.00	0.00%
Office	0.00	0.00%
Public and Private Open Space	4.27	13.13%
Retail/Commercial	0.00	0.00%
Single Family	13.50	41.49%
Transportation	6.65	20.43%
Utility and Waste Facilities	0.00	0.00%
Water	8.09	24.85%
Wetlands	0.00	0.00%
TOTAL	**32.54**	**100.00%**

Land Use	Acreage	Runoff Coeff.	Estimated Runoff, acft.	% total of Estimated Runoff
Agriculture	0.03	0.05	0.0	0.02%
Disturbed Land	0.00	0.05	0.0	0.00%
Forest and Grassland	0.00	0.05	0.0	0.00%
Govt. & Institution	0.00	0.50	0.0	0.00%
Industrial	0.00	0.80	0.0	0.00%
Multi Family	0.00	0.50	0.0	0.00%
Office	0.00	0.85	0.0	0.00%
Public & Private Open Space	4.27	0.05	0.6	2.81%
Retail/Commercial	0.00	0.75	0.0	0.00%
Single Family	13.50	0.30	11.1	53.37%
Transportation	6.65	0.50	9.1	43.79%
Utility and Waste Facilities	0.00	0.30	0.0	0.00%
Water	8.09	0.00	0.0	0.00%
Wetlands	0.00	0.05	0.0	0.00%
TOTAL	**32.54**		**20.9**	**100.00%**

Lake volume	**37.73**	**acre-feet**
Retention Time (years)= lake volume/runoff	**1.81**	**years**
	659.81	**days**

Table 2. Water quality summary for North Tower Lake, 2001, 2007 and 2013.

2013	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	TDS**	Cl	TSS	TS	TVS	SECCHI	COND	pH	DO
14-May	3	141	0.870	<0.1	<0.05	0.056	0.007	513	244	2.6	616	137	4.28	0.9265	8.43	5.27
11-Jun	3	163	1.260	<0.1	<0.05	0.081	<0.005	541	218	6.8	587	127	3.33	0.9819	8.57	10.65
9-Jul	3	152	1.240	<0.1	<0.05	0.067	0.005	542	232	5.2	546	103	2.75	0.9843	8.91	13.32
13-Aug	3	163	1.440	<0.1	<0.05	0.070	0.006	546	236	5.8	620	133	2.85	0.9910	8.23	6.92
17-Sep	3	155	0.745	<0.1	<0.05	0.043	<0.005	613	250	1.7	661	160	6.25	1.1240	8.67	11.22
	Average	155	1.111	<0.1	<0.05	0.063	0.01k	551	236	4.4	606	132	3.89	1.0015	8.56	9.48

2007	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_2+NO_3-N	TP	SRP	TDS	Cl^-	TSS	TS	TVS	SECCHI	COND	pH	DO
9-May	3	169	0.930	<0.1	<0.05	0.059	<0.005	649	261	2.8	611	100	6.40	1.1960	8.50	7.41
13-Jun	3	192	0.820	<0.1	<0.05	0.098	0.044	671	266	3.1	721	166	6.56	1.2410	7.98	6.89
11-Jul	3	193	1.080	<0.1	<0.05	0.087	0.021	706	272	3.9	727	166	4.29	1.3090	8.14	4.72
8-Aug	3	166	0.970	<0.1	<0.05	0.072	0.006	626	248	8.8	626	140	2.85	1.1500	8.72	13.36
12-Sep	3	180	1.080	<0.1	<0.05	0.123	0.015	600	230	10.0	626	141	2.95	1.0980	8.59	11.58
	Average	180	0.980	<0.1	<0.05	0.088	<0.005	650	255	5.7	662	143	4.61	1.1988	8.39	8.79

2001	Epilimnion															
DATE	DEPTH	ALK	TKN	NH_3-N	NO_3-N*	TP	SRP	TDS	Cl^{-**}	TSS	TS	TVS	SECCHI	COND	pH	DO
23-May	3	161	0.530	<0.1	<0.05	0.082	0.027	534	184	1.9	567	167	0[a]	0.9605	8.11	5.21
27-Jun	3	162	0.850	<0.1	<0.05	0.056	0.017	520	191	0.7	573	142	8.86	0.9834	8.35	9.92
1-Aug	3	153	1.370	<0.1	<0.05	0.085	0.015	598	196	6.1	613	185	3.25	0.9996	8.17	6.64
29-Aug	3	169	1.220	<0.1	<0.05	0.090	0.011	546	205	4.0	628	127	4.00	1.0290	7.92	6.35
25-Sep	3	154	0.950	<0.1	<0.05	0.046	0.005	526	185	1.2	545	137	0[a]	0.9656	8.36	9.91
	Average	160	0.980	<0.1	<0.05	0.072	0.015	545	192	2.8	585	152	5.37[b]	0.9876	8.18	7.61

Table 2. Water quality summary for North Tower Lake, 2001, 2007 and 2013.

Glossary

ALK = Alkalinity, mg/L $CaCO_3$
TKN = Total Kjeldahl nitrogen, mg/L
NH_3-N = Ammonia nitrogen, mg/L
NO_3-N = Nitrate nitrogen, mg/L
TP = Total phosphorus, mg/L
SRP = Soluble reactive phosphorus, mg/L
TDS = Total dissolved solids, mg/L
TSS = Total suspended solids, mg/L
TS = Total solids, mg/L
TVS = Total volatile solids, mg/L
SECCHI = Secchi Disk Depth, Ft.
COND = Conductivity, milliSiemens/cm
DO = Dissolved oxygen, mg/L

k = Denotes that the actual value is known to be less than the value presented.

NA= Not applicable

* = Prior to 2006 only Nitrate - nitrogen was analyzed

a = Secchi depth was obstructed by the bottom

b = Secchi disk depth average does not include data from May because Secchi disk was on the bottom and therefore the reading could have been deeper

Figure 4. Secchi depth (water clarity) in North Tower Lake during 2001, 2007 and 2013.

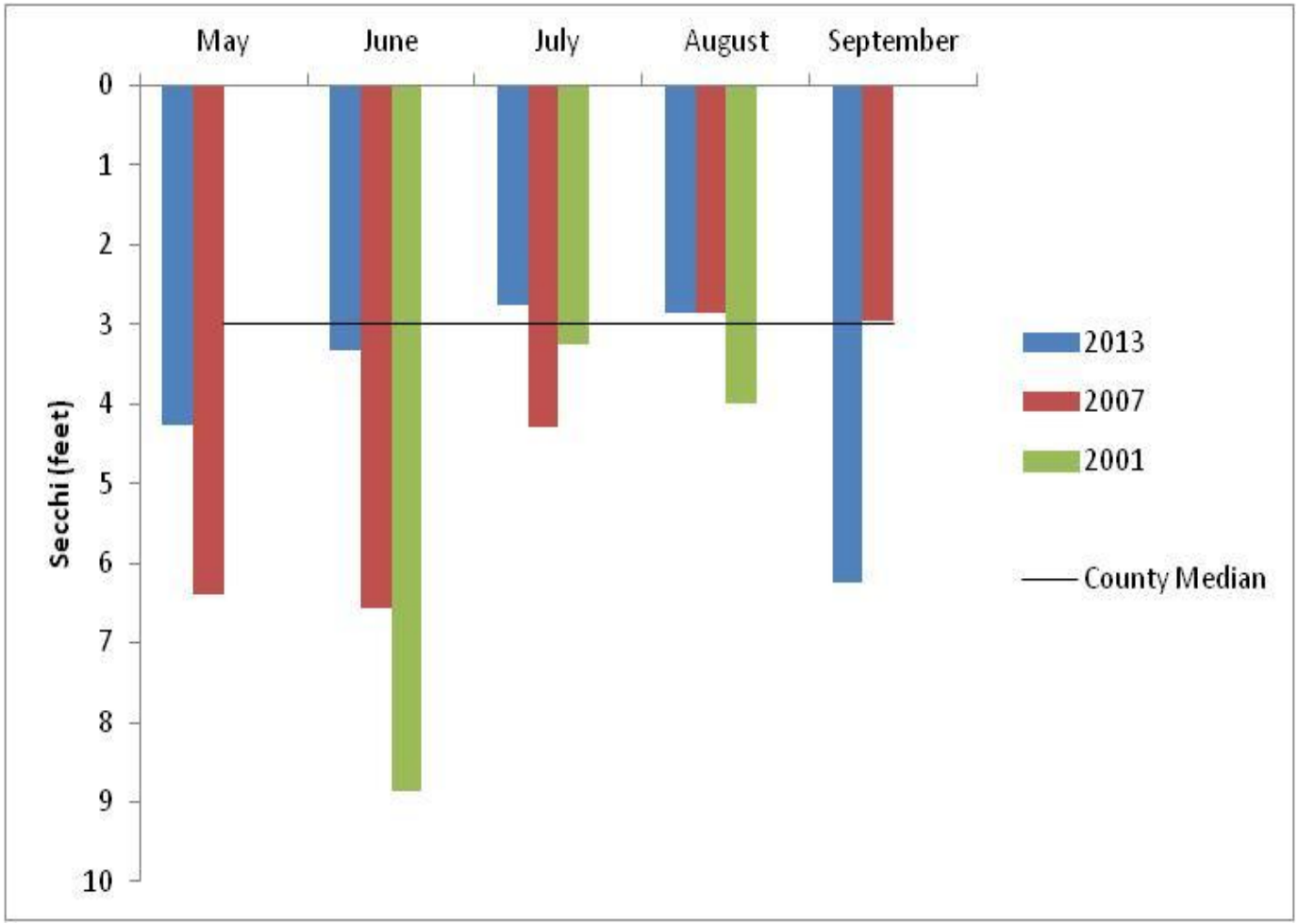

Table 3. 2000 - 2013 water quality parameters, statistics summary.

	ALKoxic <=3ft00-2013	
Average	**164**	
Median	**159**	
Minimum	**65**	**IMC**
Maximum	**330**	**Flint Lake**
STD	**42**	
n =	**863**	

	ALKanoxic 2000-2013	
Average	**198**	
Median	**187**	
Minimum	**103**	**Heron Pond**
Maximum	**470**	**Lake Marie**
STD	**53**	
n =	**231**	

	Condoxic <=3ft00-2013	
Average	**0.8667**	
Median	**0.7875**	
Minimum	**0.2260**	**Schreiber Lake**
Maximum	**6.8920**	**IMC**
STD	**0.5239**	
n =	**860**	

	Condanoxic 2000-2013	
Average	**1.0056**	
Median	**0.8360**	
Minimum	**0.3210**	**Lake Kathyrn, Schreiber Lake**
Maximum	**7.4080**	**IMC**
STD	**0.8091**	
n =	**231**	

	NO3-N, Nitrate+Nitrite,oxic <=3ft00-2013	
Average	**0.454**	
Median	**0.145**	
Minimum	**<0.05**	***ND**
Maximum	**9.670**	**South Churchill Lake**
STD	**1.016**	
n =	**863**	

*ND = Many lakes had non-detects (74.5%)
Only compare lakes with detectable concentrations to the statistics above
Beginning in 2006, Nitrate+Nitrite was measured.

	NH3-Nanoxic 2000-2013	
Average	**2.211**	
Median	**1.530**	
Minimum	**<0.1**	***ND**
Maximum	**18.400**	**Taylor Lake**
STD	**2.425**	
n =	**231**	

*ND = 29.1% Non-detects from 32 different lakes

	pHoxic <=3ft00-2013	
Average	**8.35**	
Median	**8.34**	
Minimum	**7.06**	**Deer Lake**
Maximum	**10.40**	**Summerhill Estates**
STD	**0.46**	
n =	**860**	

	pHanoxic 2000-2013	
Average	**7.27**	
Median	**7.24**	
Minimum	**6.24**	**Cranberry Lake, Banana Pond**
Maximum	**9.16**	**White Lake**
STD	**0.45**	
n =	**231**	

	All Secchi 2000-2013	
Average	**4.35**	
Median	**3.00**	
Minimum	**0.18**	**McDonald 2/Ozaukee/Rollins 2**
Maximum	**29.23**	**Bangs Lake**
STD	**3.63**	
n =	**783**	

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Table 3. 2000 - 2013 water quality parameters, statistics summary.

TKNoxic <=3ft 00-2013		
Average	**1.525**	
Median	**1.170**	
Minimum	**<0.1**	***ND**
Maximum	**41.200**	**Almond Marsh**
STD	**1.726**	
n =	**863**	

*ND = 3.5% Non-detects from 14 different lakes

TKNanoxic 2000-2013		
Average	**2.891**	
Median	**2.210**	
Minimum	**<0.5**	***ND**
Maximum	**21.000**	**Taylor Lake**
STD	**2.372**	
n =	**231**	

*ND = 3.5% Non-detects from 4 different lakes

TPoxic <=3ft 00-2013		
Average	**0.114**	
Median	**0.067**	
Minimum	**<0.01**	***ND**
Maximum	**7.270**	**Almond Marsh**
STD	**0.276**	
n =	**863**	

*ND = 1.8% Non-detects from 6 different lakes

TPanoxic 2000-2013		
Average	**0.323**	
Median	**0.180**	
Minimum	**0.012**	**Independence Grove, W. Loon**
Maximum	**3.800**	**Taylor Lake**
STD	**0.410**	
n =	**231**	

TSSall <=3ft 00-2013		
Average	**15.8**	
Median	**8.0**	
Minimum	**<1**	***ND**
Maximum	**220.0**	**Rollins 2**
STD	**22.5**	
n =	**848**	

*ND = 1.3% Non-detects from 8 different lakes

TVSoxic <=3ft 00-2013		
Average	**124.7**	
Median	**119.0**	
Minimum	**34.0**	**Pulaski Pond**
Maximum	**1090.0**	**Almond Marsh**
STD	**50.7**	
n =	**818**	

No 2002 IEPA Chain Lakes

TDSoxic <=3ft 00-2004		
Average	**470**	
Median	**454**	
Minimum	**150**	**Lake Kathryn, White**
Maximum	**1340**	**IMC**
STD	**169**	
n =	**745**	

No 2002 IEPA Chain Lakes.

CLanoxic 2000-2013		
Average	**195**	
Median	**135**	
Minimum	**3.5**	**Schreiber Lake**
Maximum	**2390**	**IMC**
STD	**310**	
n =	**178**	

CLoxic 2000-2013		
Average	**179**	
Median	**145**	
Minimum	**2.7**	**Schreiber Lake**
Maximum	**2760**	**IMC**
STD	**200**	
n =	**723**	

Anoxic conditions are defined <=1 mg/l D.O.
pH Units are equal to the -Log of [H] ion activity
Conductivity units are in MilliSiemens/cm
Secchi Disk depth units are in feet
All others are in mg/L

Minimums and maximums are based on data from all lakes from 2000-2013 (n=4476).

Average, median and STD are based on data from the most recent water quality sampling year for each lake.

LCHD Environmental Services ~ 1/21/2014

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Table 4. Average Secchi depths measured from lakes in Lake County, 2000-2013.

RANK	LAKE NAME	SECCHI AVE	TSIsd
1	Windward Lake	14.28	38.8
2	Lake Carina	13.21	39.9
3	Druce Lake	12.25	41.0
4	Pulaski Pond	11.69	41.7
5	West Loon Lake	11.55	41.9
6	Independence Grove	11.50	41.9
7	Sterling Lake	11.35	42.1
8	Lake Zurich	10.40	43.4
9	Davis Lake	9.65	44.4
10	Harvey Lake	9.47	44.7
11	Little Silver Lake	9.42	44.8
12	Old School Lake	9.40	44.8
13	Lake Kathryn	9.39	44.8
14	Dugdale Lake	9.22	45.1
15	Dog Training Pond	9.04	45.4
16	Bangs Lake	8.90	45.0
17	Banana Pond	8.85	45.7
18	Deep Lake	8.83	45.7
19	Stone Quarry Lake	8.81	45.8
20	Lake of the Hollow	8.74	45.9
21	Cedar Lake	8.25	47.0
22	Cross Lake	8.18	46.8
23	Ames Pit	8.14	46.9
24	Briarcrest Pond	8.00	47.1
25	Cranberry Lake	7.88	46.0
26	Sand Lake	7.48	48.1
27	Sand Pond (IDNR)	7.42	48.2
28	Timber Lake (North)	7.37	48.3
29	Lake Miltmore	7.35	48.4
30	Lake Leo	7.31	48.4
31	Schreiber Lake	7.25	48.6
32	Nielsen Pond	7.23	48.6
33	Honey Lake	7.17	48.7
34	Lake Minear	7.13	48.8
35	Round Lake	7.01	49.1
36	Highland Lake	6.97	49.1
37	Channel Lake	6.65	49.8
38	Third Lake	6.60	50.0
39	Lake Catherine	6.58	50.0
40	Lake Helen	6.43	50.3
41	Sun Lake	6.33	50.5
42	Wooster Lake	6.21	51.0
43	Lake Barrington	6.12	51.0
44	Lake Fairfield	5.89	51.6
45	Countryside Lake	5.56	52.0
46	Gages Lake	5.45	52.7
47	Owens Lake	5.30	53.1
48	Valley Lake	5.05	53.8

Table 4. Average Secchi depths measured from lakes in Lake County, 2000-2013.

RANK	LAKE NAME	SECCHI AVE	TSIsd
49	McGreal Lake	5.04	53.8
50	Old Oak Lake	4.85	54.4
51	Waterford Lake	4.70	54.8
52	Lake Linden	4.60	55.1
53	Peterson Pond	4.51	55.4
54	Timber Lake (South)	4.46	56.0
55	Crooked Lake	4.39	55.8
56	Mary Lee Lake	4.35	55.9
57	Butler Lake	4.35	55.9
58	Crooked Lake	4.28	56.2
59	Deer Lake	4.20	56.4
60	Seven Acre Lake	4.18	56.5
61	Lambs Farm Lake	4.17	56.5
62	Grays Lake	4.08	56.9
63	Lake Naomi	4.05	57.0
64	White Lake	3.96	57.3
65	Hook Lake	3.95	57.3
66	Turner Lake	3.92	57.4
67	North Tower Lake	3.89	60.0
68	Leisure Lake	3.85	57.7
69	Salem Lake	3.77	58.0
70	Lake Fairview	3.75	58.0
71	Countryside Glen Lake	3.64	58.5
72	Taylor Lake	3.52	59.0
73	Hastings Lake	3.52	59.0
74	Duck Lake	3.49	59.1
75	Fish Lake	3.47	59.2
76	Bishop Lake	3.47	59.2
77	Lake Lakeland Estates	3.41	59.0
78	Lake Holloway	3.40	59.5
79	Stockholm Lake	3.38	59.6
80	East Loon Lake	3.30	59.9
81	Bresen Lake	3.28	60.0
82	Summerhill Estates Lake	3.27	60.0
83	Lucky Lake	3.22	60.3
84	Diamond Lake	3.17	60.5
85	Liberty Lake	3.16	60.5
86	International Mining and Chemical Lake	3.08	60.9
87	Lake Christa	3.01	61.2
88	Lucy Lake	2.99	61.3
89	Long Lake	2.87	62.0
90	Bluff Lake	2.85	62.0
91	St. Mary's Lake	2.79	62.3
92	Werhane Lake	2.71	62.8
93	Petite Lake	2.66	63.0
94	East Meadow Lake	2.61	63.3
95	Buffalo Creek Reservoir 1	2.60	64.0
96	Kemper Lake 1	2.56	63.6

Table 4. Average Secchi depths measured from lakes in Lake County, 2000-2013.

RANK	LAKE NAME	SECCHI AVE	TSIsd
97	Broberg Marsh	2.50	63.9
98	Antioch Lake	2.48	64.0
99	Spring Lake	2.46	64.2
100	Little Bear Lake	2.38	64.6
101	Island Lake	2.32	65.0
102	Tower Lake	2.31	56.0
103	Buffalo Creek Reservoir 2	2.30	67.0
104	Woodland Lake	2.28	65.0
105	Lake Marie	2.25	65.4
106	Rivershire Pond 2	2.23	65.6
107	Lake Charles	2.20	65.8
108	College Trail Lake	2.18	65.9
109	Loch Lomond	2.17	66.0
110	Echo Lake	2.11	66.4
111	Eagle Lake (S1)	2.10	66.4
112	West Meadow Lake	2.07	66.6
113	Forest Lake	2.04	66.9
114	Grand Ave Marsh	2.03	66.9
115	Columbus Park Lake	2.03	66.9
116	Grassy Lake	2.00	67.1
117	Sylvan Lake	1.98	67.3
118	Bittersweet Golf Course #13	1.98	67.3
119	Fischer Lake	1.96	67.4
120	Pistakee Lake	1.88	68.0
121	Kemper Lake 2	1.77	68.9
122	Fourth Lake	1.77	68.9
123	Nippersink Lake	1.73	69.2
124	Deer Lake Meadow Lake	1.73	69.2
125	Lake Louise	1.68	69.7
126	Willow Lake	1.63	70.1
127	Slough Lake	1.63	70.1
128	Rasmussen Lake	1.62	70.2
129	Lake Farmington	1.62	70.2
130	Half Day Pit	1.60	70.4
131	Dunn's Lake	1.54	70.9
132	Longview Meadow Lake	1.51	71.2
133	Lake Matthews	1.41	72.2
134	Fox Lake	1.37	72.6
135	Grass Lake	1.33	73.0
136	Big Bear Lake	1.32	73.1
137	Lake Nippersink	1.28	73.6
138	Redhead Lake	1.27	73.7
139	Lake Eleanor	1.16	75.0
140	McDonald Lake 1	1.13	75.4
141	Lake Napa Suwe	1.06	105.0
142	Rollins Savannah 1	1.05	76.4
143	Osprey Lake	1.03	76.7
144	Manning's Slough	1.00	77.1

Table 4. Average Secchi depths measured from lakes in Lake County, 2000-2013.

RANK	LAKE NAME	SECCHI AVE	TSIsd
145	Rollins Savannah 2	0.95	77.9
146	Dog Bone Lake	0.94	78.0
147	Redwing Marsh	0.88	79.0
148	Flint Lake Outlet	0.83	79.8
149	Slocum Lake	0.81	80.0
150	Fairfield Marsh	0.81	80.2
151	Oak Hills Lake	0.79	80.5
152	South Churchill Lake	0.73	81.7
153	Lake Forest Pond	0.71	82.1
54	ADID 127	0.66	83.1
155	North Churchill Lake	0.61	84.3
156	Hidden Lake	0.56	85.5
157	Ozaukee Lake	0.51	86.8
158	McDonald Lake 2	0.50	87.1

Table 5. Lake County average TSI phosphorus (TSIp) ranking 2000-2013.

RANK	LAKE NAME	TP AVE	TSIp
1	Lake Carina	0.0100	37.35
2	Sterling Lake	0.0100	37.35
3	Independence Grove	0.0130	41.14
4	Lake Zurich	0.0135	41.68
5	Druce Lake	0.0140	42.00
6	Windward Lake	0.0160	44.13
7	Sand Pond (IDNR)	0.0165	44.57
8	West Loon	0.0170	45.00
9	Pulaski Pond	0.0180	45.83
10	Banana Pond	0.0200	47.35
11	Cedar Lake	0.0200	47.35
12	Gages Lake	0.0200	47.35
13	Lake Kathryn	0.0200	47.35
14	Lake Minear	0.0200	47.35
15	Highland Lake	0.0202	47.49
16	Lake Miltmore	0.0210	48.00
17	Timber Lake (North)	0.0210	48.05
18	Cross Lake	0.0220	48.72
19	Dog Training Pond	0.0220	48.72
20	Sun Lake	0.0220	48.72
21	Deep Lake	0.0230	49.36
22	Lake of the Hollow	0.0230	49.36
23	Round Lake	0.0230	49.36
24	Stone Quarry Lake	0.0230	49.36
25	Bangs Lake	0.0240	50.00
26	Little Silver Lake	0.0250	50.57
27	Lake Leo	0.0260	51.13
28	Cranberry Lake	0.0270	51.68
29	Dugdale Lake	0.0270	51.68
30	Peterson Pond	0.0270	51.68
31	Fourth Lake	0.0360	53.00
32	Lake Fairfield	0.0300	53.20
33	Third Lake	0.0300	53.20
34	Lake Catherine	0.0310	53.67
35	Lambs Farm Lake	0.0310	53.67
36	Old School Lake	0.0310	53.67
37	Grays Lake	0.0310	54.00
38	Harvey Lake	0.0320	54.50
39	Hendrick Lake	0.0340	55.00
40	Honey Lake	0.0340	55.00
41	Sand Lake	0.0380	56.00
42	Sullivan Lake	0.0370	56.22
43	Channel Lake	0.0380	56.60
44	Ames Pit	0.0390	56.98
45	Diamond Lake	0.0390	56.98
46	East Loon	0.0400	57.34
47	Schreiber Lake	0.0400	57.34
48	Waterford Lake	0.0400	57.34
49	Hook Lake	0.0410	57.70
50	Duck Lake	0.0430	58.39
51	Nielsen Pond	0.0450	59.04
52	Seven Acre Lake	0.0460	59.36

Table 5. Lake County average TSI phosphorus (TSIp) ranking 2000-2013.

RANK	LAKE NAME	TP AVE	TSIp
53	Turner Lake	0.0460	59.36
54	Willow Lake	0.0460	59.36
55	East Meadow Lake	0.0480	59.97
56	Lucky Lake	0.0480	59.97
57	Old Oak Lake	0.0490	60.27
58	College Trail Lake	0.0500	60.56
59	Hastings Lake	0.0520	61.13
60	Butler Lake	0.0530	61.40
61	West Meadow Lake	0.0530	61.40
62	Lucy Lake	0.0550	61.94
63	Lake Linden	0.0570	62.45
64	Lake Christa	0.0580	62.70
65	Owens Lake	0.0580	62.70
66	Briarcrest Pond	0.0580	63.00
67	Lake Barrington	0.0600	63.10
68	Lake Lakeland Estates	0.0620	63.66
69	Lake Naomi	0.0620	63.66
70	Lake Tranquility (S1)	0.0620	63.66
71	Liberty Lake	0.0630	63.89
72	North Tower Lake	0.0630	63.89
73	Werhane Lake	0.0630	63.89
74	Countryside Glen Lake	0.0640	64.12
75	Countryside Lake	0.0660	65.00
76	Davis Lake	0.0650	64.34
77	Leisure Lake	0.0650	64.34
78	St. Mary's Lake	0.0670	64.78
79	Little Bear Lake	0.0680	65.00
80	Buffalo Creek Reservoir 1	0.0680	65.00
81	Mary Lee Lake	0.0680	65.00
82	Wooster Lake	0.0700	65.41
83	Crooked Lake	0.0710	66.00
84	Timber Lake (South)	0.0720	65.82
85	Lake Helen	0.0720	65.82
86	Grandwood Park Lake	0.0720	65.82
87	ADID 203	0.0730	66.02
88	Bluff Lake	0.0730	66.02
89	Long Lake	0.0730	66.02
90	Spring Lake	0.0730	66.02
91	Broberg Marsh	0.0780	66.97
92	Woodland Lake	0.0800	68.00
93	Redwing Slough	0.0822	67.73
94	Tower Lake	0.0830	67.87
95	Petite Lake	0.0830	67.87
96	Lake Marie	0.0850	68.21
97	Potomac Lake	0.0850	68.21
98	White Lake	0.0862	68.42
99	Grand Ave Marsh	0.0870	68.55
100	North Churchill Lake	0.0870	68.55
101	McDonald Lake 1	0.0880	68.71
102	Lake Fairview	0.0890	68.00
103	Rivershire Pond 2	0.0900	69.04
104	South Churchill Lake	0.0900	69.04

Table 5. Lake County average TSI phosphorus (TSIp) ranking 2000-2013.

RANK	LAKE NAME	TP AVE	TSIp
105	McGreal Lake	0.0910	69.20
106	Lake Charles	0.0930	69.40
107	Deer Lake	0.0940	69.66
108	Dunn's Lake	0.0950	69.82
109	Eagle Lake (S1)	0.0950	69.82
110	International Mine and Chemical Lake	0.0950	69.82
111	Valley Lake	0.0950	69.82
112	Big Bear Lake	0.0960	69.97
113	Buffalo Creek Reservoir 2	0.0960	69.97
114	Fish Lake	0.0960	69.97
115	Lochanora Lake	0.0960	69.97
116	Nippersink Lake	0.1000	70.56
117	Sylvan Lake	0.1000	70.56
118	Longview Meadow Lake	0.1020	70.84
119	Lake Forest Pond	0.1070	71.53
120	Bittersweet Golf Course #13	0.1100	71.93
121	Fox Lake	0.1100	71.93
122	Kemper 2	0.1100	71.93
123	Middlefork Savannah Outlet 1	0.1120	72.00
124	Osprey Lake	0.1110	72.06
125	Bresen Lake	0.1130	72.32
126	Round Lake Marsh North	0.1130	72.32
127	Deer Lake Meadow Lake	0.1160	72.70
128	Taylor Lake	0.1180	72.94
129	Island Lake	0.1210	73.00
130	Columbus Park Lake	0.1230	73.54
131	Lake Nippersink	0.1240	73.66
132	Echo Lake	0.1250	73.77
133	Grass Lake	0.1290	74.23
134	Lake Holloway	0.1320	74.56
135	Redhead Lake	0.1410	75.51
136	Antioch Lake	0.1450	75.91
137	Slocum Lake	0.1500	77.00
138	Lakewood Marsh	0.1510	76.50
139	Pond-A-Rudy	0.1510	76.50
140	Lake Matthews	0.1520	76.59
141	Forest Lake	0.1540	76.78
142	Middlefork Savannah Outlet 2	0.1590	77.00
143	Pistakee Lake	0.1590	77.24
144	Grassy Lake	0.1610	77.42
145	Salem Lake	0.1650	77.78
146	Half Day Pit	0.1690	78.12
147	Lake Eleanor	0.1810	79.11
148	Lake Farmington	0.1850	79.43
149	Lake Louise	0.1850	79.43
150	ADID 127	0.1890	79.74
151	Lake Napa Suwe	0.1940	80.00
152	Patski Pond	0.1970	80.33
153	Dog Bone Lake	0.1990	80.48
154	Summerhill Estates Lake	0.1990	80.48
155	Redwing Marsh	0.2070	81.05
156	Stockholm Lake	0.2082	81.13

Table 5. Lake County average TSI phosphorus (TSIp) ranking 2000-2013.

RANK	LAKE NAME	TP AVE	TSIp
157	Bishop Lake	0.2160	81.66
158	Ozaukee Lake	0.2200	81.93
159	Kemper 1	0.2220	82.08
160	Hidden Lake	0.2240	82.19
161	McDonald Lake 2	0.2250	82.28
162	Fischer Lake	0.2280	82.44
163	Oak Hills Lake	0.2790	85.35
164	Loch Lomond	0.2950	86.16
165	Heron Pond	0.2990	86.35
166	Rollins Savannah 1	0.3070	87.00
167	Fairfield Marsh	0.3260	87.60
168	ADID 182	0.3280	87.69
169	Manning's Slough	0.3820	90.22
170	Slough Lake	0.3860	90.03
171	Rasmussen Lake	0.4860	93.36
172	Albert Lake, Site II, outflow	0.4950	93.67
173	Flint Lake Outlet	0.5000	93.76
174	Rollins Savannah 2	0.5870	96.00
175	Almond Marsh	1.9510	113.00

Table 6. Multiparameter data for North Tower Lake, 2013.

North Tower Lake 2013 Multiparameter data

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average
5/21/2013	0.25	0.48	25.00	5.15	63.0	0.9312	8.41	1416	Surface	
5/21/2013	1	1.01	24.99	5.12	62.6	0.9303	8.39	1448	Surface	100%
5/21/2013	2	2.03	24.42	5.24	63.5	0.9277	8.43	488	-0.66	34%
5/21/2013	3	2.98	24.14	5.31	63.9	0.9259	8.43	146	0.36	10%
5/21/2013	4	4.00	23.08	5.43	64.1	0.9186	8.53	128	1.31	9%
5/21/2013	5	5.03	20.40	4.72	53.1	0.9121	8.41	121	2.33	8%
5/21/2013	6	6.02	18.65	3.39	36.6	0.9295	8.06	95	3.36	7%
5/21/2013	7	7.13	18.15	2.97	31.8	0.9413	7.81	70	4.35	5%

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average
6/18/2013	0.25	0.64	24.71	11.24	135.5	1.1240	8.61	1734	Surface	
6/18/2013	1	1.05	24.72	11.30	136.2	1.1240	8.66	1662	Surface	100%
6/18/2013	2	2.01	24.73	11.30	136.2	1.1240	8.66	318	0.34	19%
6/18/2013	3	3.00	24.72	11.23	135.3	1.1250	8.67	235	1.33	14%
6/18/2013	4	3.64	24.72	11.21	135.1	1.1240	8.67	226	1.97	14%
6/18/2013	5	5.06	24.67	10.81	130.2	1.1250	8.65	239	3.39	14%
6/18/2013	6	6.02	24.46	9.24	110.8	1.1290	8.55	188	4.35	11%
6/18/2013	7	7.00	24.32	6.57	78.6	1.1340	8.24	139	5.33	8%

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average
7/16/2013	0.25	0.78	30.13	10.49	137.7	0.9832	8.62	4594	Surface	
7/16/2013	1	1.07	30.06	11.10	145.6	0.9820	8.63	4904	Surface	100%
7/16/2013	2	2.31	29.58	11.38	147.9	0.9805	8.63	2002	0.64	41%
7/16/2013	3	2.98	28.99	10.65	137.1	0.9819	8.57	532	1.31	11%
7/16/2013	4	3.85	28.78	9.14	117.2	0.9820	8.42	871	2.18	18%
7/16/2013	5	6.12	27.28	2.33	29.2	0.9846	7.62	364	4.45	7%
7/16/2013	6	6.5	26.42	0.45	5.6	0.9834	7.38	264	4.83	5%
7/16/2013	7	8.06	25.99	0.33	4.0	0.9866	7.26	103	6.39	2%

Table 6. Multiparameter data for North Tower Lake, 2013.

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average
8/20/2013	0.25	0.25	24.61	14.18	170.0	0.9849	8.93	3465	Surface	
8/20/2013	1	1.00	24.54	14.33	171.8	0.9841	8.94	3227	Surface	100%
8/20/2013	2	2.00	24.38	14.08	166.8	0.9833	8.92	1262	0.33	39%
8/20/2013	3	3.00	24.28	13.32	166.5	0.9843	8.91	743	1.33	23%
8/20/2013	4	4.00	24.20	10.93	126.8	0.9912	8.49	400	2.33	12%
8/20/2013	5	5.00	23.69	2.76	32.1	0.9985	8.02	298	3.33	9%
8/20/2013	6	6.00	23.40	0.78	8.9	1.0060	7.40	167	4.33	5%
8/20/2013	7	7.00	23.23	0.34	4.0	1.0220	6.82	92	5.33	3%

Date MMDDYY	Text Depth feet	Dep25 feet	Temp øC	DO mg/l	DO% Sat	SpCond mS/cm	pH Units	PAR æE/s/mý	Depth of Light Meter feet	% Light Transmission Average
9/17/2013	0.25	0.25	19.12	7.01	74.9	0.9913	8.21	3896	Surface	
9/17/2013	1	1.00	19.12	6.92	73.9	0.9921	8.20	3312	Surface	100%
9/17/2013	2	2.00	19.08	6.9	73.7	0.9919	8.23	307	0.33	9%
9/17/2013	3	3.00	19.04	6.92	73.9	0.9910	8.23	190	1.33	6%
9/17/2013	4	4.00	18.28	6.83	72.5	0.9900	8.22	409	2.33	12%
9/17/2013	6	5.00	18.47	6.49	66.2	0.9912	8.14	290	3.33	9%
9/17/2013	8	6.00	18.40	5.76	60.6	0.9930	8.10	95	4.33	3%
9/17/2013	7	7.00	18.36	4.05	43.6	0.9917	8.06	82	16.69	2%

Figure 5. TP concentrations measured in North Tower Lake, 2001, 2007 and 2013.

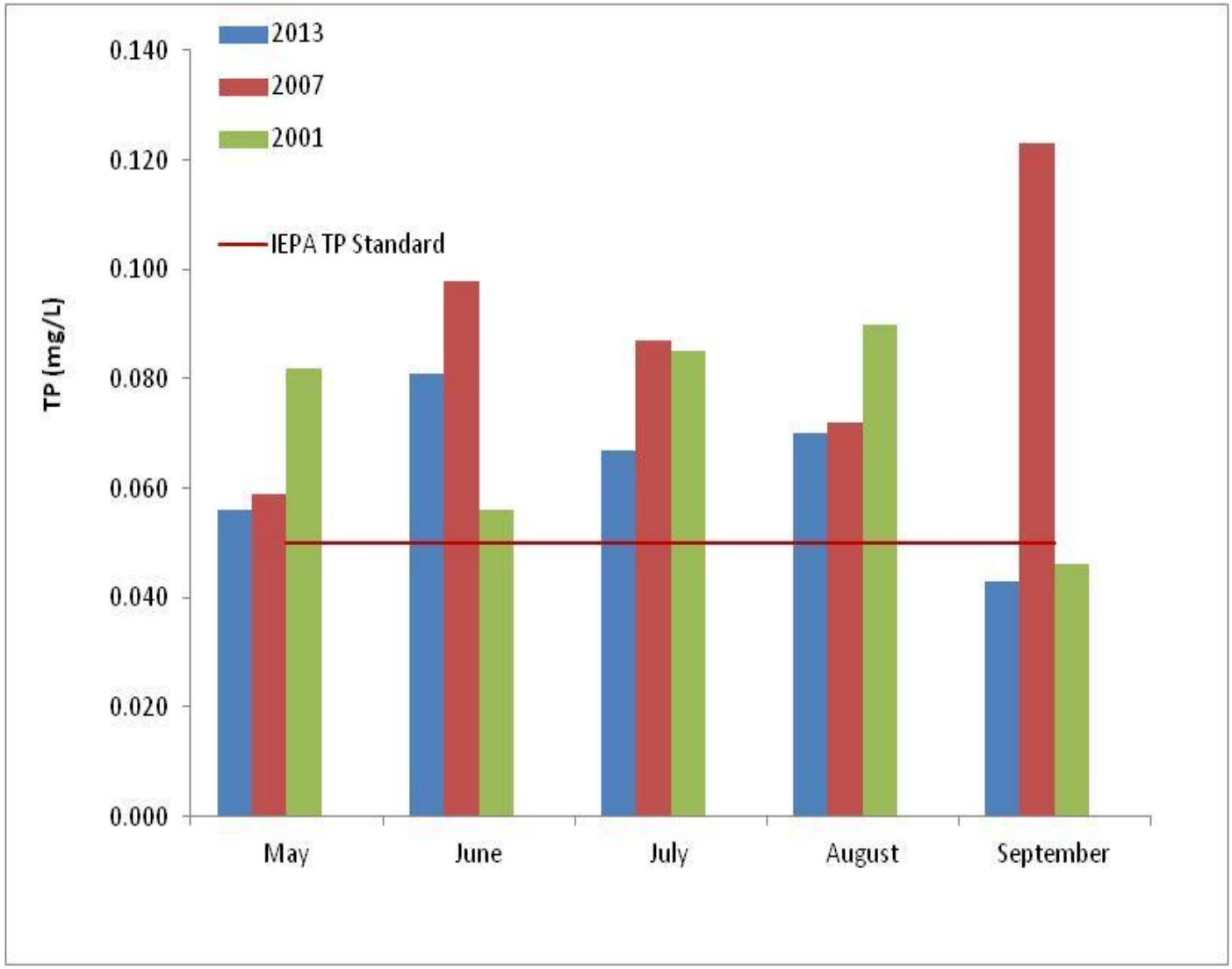

Table 7a. Aquatic Plants found at the 31sampling sites on North Tower Lake in July, 2013. The maximum depth that plants were found was 7.0 feet.

Plant Density	Chara	Small Pondweed
Absent	18	15
Present	5	7
Common	3	5
Abundant	5	4
Dominant	0	0
% Plant Occurrence	41.9	51.6

Table 7b. Distribution of rake density across all sampling sites.

Rake Density (coverage)	# of Sites	% of Sites
No Plants	9	29
>0-10%	6	19
10-40%	8	26
40-60%	8	26
60-90%	0	0
>90%	0	0
Total Sites with Plants	22	71
Total # of Sites	31	100

Figure 6. Estimated rake density of vegetation occurring in North Tower Lake, 2013.

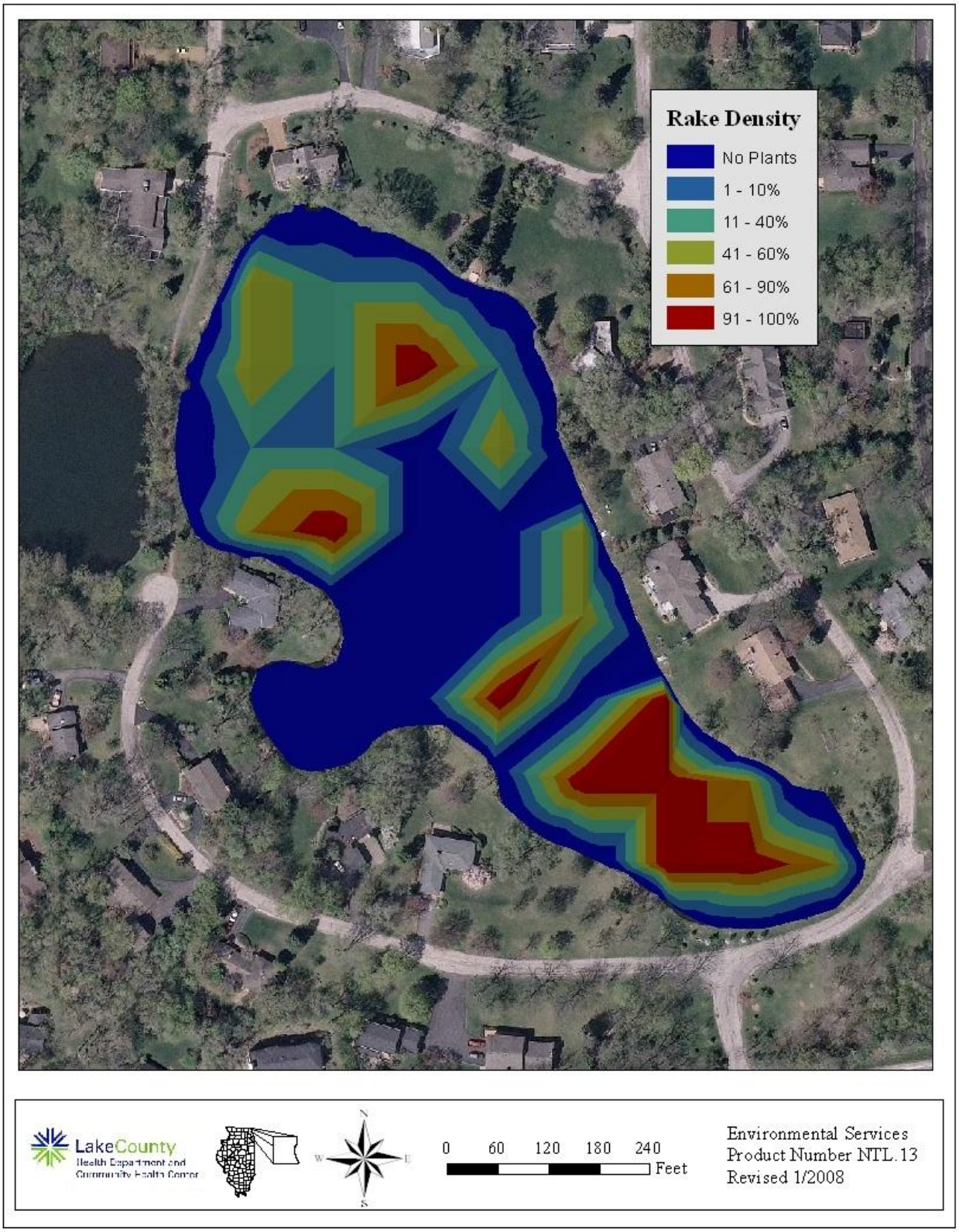

Table 8. Lake County average Floristic Quality Index ranking 2000 – 2013.

RANK	LAKE NAME	FQI (w/A)	FQI (native)
1	Cedar Lake	38.0	36.6
2	East Loon Lake	34.7	36.1
3	Cranberry Lake	29.7	29.7
4	Deep Lake	29.7	31.2
5	Bangs Lake	29.6	26.0
6	Little Silver Lake	29.6	31.6
7	Round Lake Marsh North	29.1	29.9
8	West Loon Lake	27.1	29.5
9	Sullivan Lake	26.9	28.5
10	Third Lake	25.1	22.5
11	Fourth Lake	24.7	27.1
12	Independence Grove	24.6	27.5
13	Sterling Lake	24.5	26.9
14	Sun Lake	24.3	26.1
15	Lake Zurich	24.3	27.1
16	Redwing Slough	24.0	25.8
17	Schreiber Lake	23.9	24.8
18	Lakewood Marsh	23.8	24.7
19	Deer Lake	23.5	24.4
20	Round Lake	23.5	25.9
21	Honey Lake	23.3	25.1
22	Lake of the Hollow	23.0	24.8
23	Wooster Lake	22.8	21.1
24	Cross Lake	22.4	24.2
25	Countryside Glen Lake	21.9	22.8
26	Davis Lake	21.4	21.4
27	Butler Lake	21.4	23.1
28	Lake Barrington	21.2	21.2
29	Duck Lake	21.1	22.9
30	Timber Lake (North)	20.9	23.4
31	ADID 203	20.5	20.5
32	Broberg Marsh	20.5	21.4
33	McGreal Lake	20.2	22.1
34	Lake Kathryn	19.6	20.7
35	Fish Lake	19.3	21.2
36	Redhead Lake	19.3	21.2
37	Druce Lake	19.1	21.8
38	Turner Lake	18.6	21.2
39	Salem Lake	18.5	20.2
40	Lake Helen	18.0	18.0
41	Old Oak Lake	18.0	19.1
42	Potomac Lake	17.8	17.8
43	Long Lake	17.7	15.8
44	Hendrick Lake	17.7	17.7
45	Rollins Savannah 2	17.7	17.7
46	Grandwood Park Lake	17.2	19.0
47	Seven Acre Lake	17.0	15.5
48	Lake Miltmore	16.8	18.7
49	McDonald Lake 1	16.7	17.7
50	Highland Lake	16.7	18.9
51	Bresen Lake	16.6	17.8
52	Almond Marsh	16.3	17.3
53	Owens Lake	16.3	17.3
54	Windward Lake	16.3	17.6
55	Grays Lake	16.1	16.1
56	White Lake	16.0	17.0
57	Dog Bone Lake	15.7	15.7
58	Osprey Lake	15.5	17.3

Table 8. Lake County average Floristic Quality Index ranking 2000 – 2013.

RANK	LAKE NAME	FQI (w/A)	FQI (native)
59	Heron Pond	15.1	15.1
60	North Churchill Lake	15.0	15.0
61	Hastings Lake	15.0	17.0
62	Lake Tranquility (S1)	15.0	17.0
63	Forest Lake	14.8	15.9
64	Dog Training Pond	14.7	15.9
65	Island Lake	14.7	16.6
66	Grand Ave Marsh	14.3	16.3
67	Nippersink Lake	14.3	16.3
68	Taylor Lake	14.3	16.3
69	Manning's Slough	14.1	16.3
70	Tower Lake	14.0	14.0
71	Dugdale Lake	14.0	15.1
72	Eagle Lake (S1)	14.0	15.1
73	Crooked Lake	14.0	16.0
74	Longview Meadow Lake	13.9	13.9
75	Bishop Lake	13.4	15.0
76	Ames Pit	13.4	15.5
77	Mary Lee Lake	13.1	15.1
78	Old School Lake	13.1	15.1
79	Dunn's Lake	12.7	13.9
80	Summerhill Estates Lake	12.7	13.9
81	Buffalo Creek Reservoir 1	12.5	11.4
82	Buffalo Creek Reservoir 2	12.5	11.4
83	McDonald Lake 2	12.5	12.5
84	Rollins Savannah 1	12.5	12.5
85	Stone Quarry Lake	12.5	12.5
86	Kemper Lake 1	12.2	13.4
87	Pond-A-Rudy	12.1	12.1
88	Stockholm Lake	12.1	13.5
89	Lake Carina	12.1	14.3
90	Lake Leo	12.1	14.3
91	Lambs Farm Lake	12.1	14.3
92	Grassy Lake	12.0	12.0
93	Lake Matthews	12.0	12.0
94	Flint Lake Outlet	11.8	13.0
95	Albert Lake	11.5	10.3
96	Rivershire Pond 2	11.5	13.3
97	Antioch Lake	11.3	13.4
98	Hook Lake	11.3	13.4
99	Briarcrest Pond	11.2	12.5
100	Lake Naomi	11.2	12.5
101	Pulaski Pond	11.2	12.5
102	Lake Napa Suwe	11.0	11.0
103	Redwing Marsh	11.0	11.0
104	West Meadow Lake	11.0	11.0
105	Lake Minear	11.0	13.9
106	Nielsen Pond	10.7	12.0
107	Lake Holloway	10.6	10.6
108	Sylvan Lake	10.6	10.6
109	Crooked Lake	10.2	12.5
110	Gages Lake	10.2	12.5
111	College Trail Lake	10.0	10.0
112	Valley Lake	9.9	9.9
113	Werhane Lake	9.8	12.0
114	Loch Lomond	9.4	12.1
115	Columbus Park Lake	9.2	9.2
116	Lake Lakeland Estates	9.2	9.2
117	Waterford Lake	9.2	9.2
118	Lake Fairfield	9.0	10.4
119	Lake Louise	9.0	10.4

Table 8. Lake County average Floristic Quality Index ranking 2000 – 2013.

RANK	LAKE NAME	FQI (w/A)	FQI (native)
120	Fischer Lake	9.0	11.0
121	Lake Fairview	8.5	6.9
122	Timber Lake (South)	8.5	6.9
123	East Meadow Lake	8.5	8.5
124	South Churchill Lake	8.5	8.5
125	Kemper Lake 2	8.5	9.8
126	Lake Christa	8.5	9.8
127	Lake Farmington	8.5	9.8
128	Lucy Lake	8.5	9.8
129	Bittersweet Golf Course #13	8.1	8.1
130	Lake Linden	8.0	8.0
131	Sand Lake	8.0	10.4
132	Countryside Lake	7.7	11.5
133	Fairfield Marsh	7.5	8.7
134	Lake Eleanor	7.5	8.7
135	Banana Pond	7.5	9.2
136	Slocum Lake	7.1	5.8
137	Lucky Lake	7.0	7.0
138	North Tower Lake	7.0	7.0
139	Lake Forest Pond	6.9	8.5
140	Ozaukee Lake	6.7	8.7
141	Leisure Lake	6.4	9.0
142	Peterson Pond	6.0	8.5
143	Little Bear Lake	5.8	7.5
144	Deer Lake Meadow Lake	5.2	6.4
145	ADID 127	5.0	5.0
146	Island Lake	5.0	5.0
147	Liberty Lake	5.0	5.0
148	Oak Hills Lake	5.0	5.0
149	Slough Lake	5.0	5.0
150	International Mining and Chemical Lake	5.0	7.1
151	Diamond Lake	3.7	5.5
152	Lake Charles	3.7	5.5
153	Big Bear Lake	3.5	5.0
154	Sand Pond (IDNR)	3.5	5.0
155	Harvey Lake	3.3	5.0
156	Half Day Pit	2.9	5.0
157	Lochanora Lake	2.5	5.0
158	Echo Lake	0.0	0.0
159	Hidden Lake	0.0	0.0
160	St. Mary's Lake	0.0	0.0
161	Willow Lake	0.0	0.0
162	Woodland Lake	0.0	0.0

Figure 7. Shoreline erosion on North Tower Lake, 2013.